CISCO ULTRA-RELIABLE WIRELESS BACKHAUL FLUIDITY SPECIFICATIONS

Fluidity system design

The Cisco Fluidity (formerly Fluidmesh Fluidity) network architecture is based on Prodigy 2.0. This is a Multiprotocol Label Switching (MPLS)-based technology used to deliver IP-encapsulated data.

MPLS provides an end-to-end packet delivery service that operates between levels 2 and 3 of the OSI network stack. MPLS relies on label identifiers (as opposed to the network destination address, as in traditional IP routing) to determine the sequence of nodes that must be traversed to reach the end of the path.

An MPLS-enabled device is also called a Label-Switched Router (LSR). A sequence of LSR nodes that is configured to deliver packets from the ingress point to the egress point using label switching is called a Label Switched Path (LSP) or 'tunnel'. Label-switched routers and other traditional IP-based devices that are located on the borders of MPLS-enabled networks are called Label Edge Routers (LERs).

The ingress node classifies an incoming packet according to a set of Forwarding Equivalence Classes (FECs). If a packet matches a particular class, it is marked with the label associated with that class, then forwarded to the next node in the sequence (according to the node's Forwarding Information Table (FIB) data). Subsequently, each intermediate node manipulates the MPLS label(s) stored in the packet before forwarding the data to the next node. The egress node removes the FEC label, handling the packet using normal IP routing functions.

The forwarding information tables on each network node are managed according to a Label Distribution Protocol (LDP). The LDP is the primary component of the so-called network control plane. Fluidity relies on a custom label-distribution protocol that provides automated installation of LSPs among the network nodes, ensuring that each node can be reached from any other node. In traditional MPLS networks, whenever the network topology changes for any reason, the node FIBs involved must be reconfigured to adapt to the new paths. This is usually done using whatever standard label distribution protocol signaling is available.

In a Cisco Ultra-Reliable Wireless Backhaul mobility network scenario, the handoff process can be assimilated to a network topology change in which an existing link is broken and a new link is created. However, industry-standard mechanisms to detect the change and reconfigure the nodes are too slow and data-intensive to provide adequate performance within a constrained real-time scenario (such as high-speed mobility). In particular, reconfiguration latency and the number of messages exchanged need to be minimized to reduce any chance of data packets being lost in the process.

To mitigate the abovementioned issues, Fluidity implements a fast handoff solution that provides very fast path reconfiguration, with latency in the order of one millisecond. The active mechanism is an extension of the network's existing control plane, and is based on a specific manipulation technique concerning the node MPLS FIB tables.

The Fluidity scheme allows mobile nodes and the client devices attached to them to maintain their IP address throughout the mobility process. In addition, all nodes are part of a single layer-2 mesh network. In technical literature, this management model is often referred to as *micro-mobility*. The layer-3 handoff process is seamless in the sense that, thanks to a make-before-break strategy, the availability of at least one valid LSP is ensured during the handoff transition as the network is reconfigured.

The rest of this manual, will make reference to the following image, which illustrates a sample mobility network scenario:

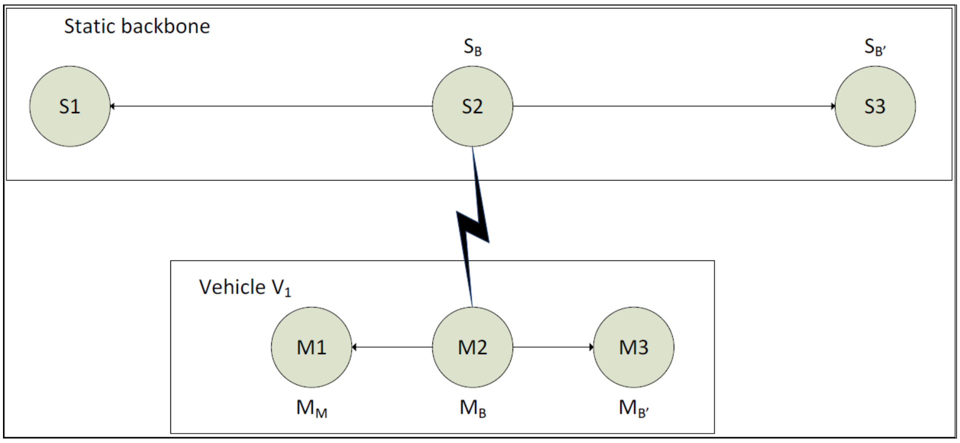

Figure 1. Logical Topology (Mobility Scenario)

All radio transceivers belonging to the same physical system are said to form a *mobility domain*. The wired static backbone and each individual vehicle are examples of distinct mobility domains, which are represented in the picture as boxes.

The LSR nodes of the backbone (S1, S2 and S3, Figure 1) install automatic LSPs to ensure full connectivity across the network.

The mobility vehicle can be equipped with multiple mobile nodes to improve network redundancy and resiliency. The routers and devices are connected using a layer-2 connection (for example, a network switch). The nodes that are part of each given vehicle install automatic LSPs among themselves. The radio with the lowest mesh ID is elected as Primary among all mobile nodes on the same vehicle. The Primary radio processes all traffic flowing between the onboard devices and the backbone hosts, and manages the wireless link that is currently used by the vehicle to connect to the backbone (taking the appropriate decisions with respect to which wireless node is selected for communication to and from the backbone among all available onboard nodes).

LSPs connecting to the static backbone are installed and updated whenever the vehicle performs the handoff procedure using dedicated signaling.

System Configuration

When the Fluidity plug-in is installed and Prodigy 2.0 is enabled, new pages become available in the relevant device's offline Configurator interface. The *Fluidity Settings* configuration controls are shown in Figure 2:

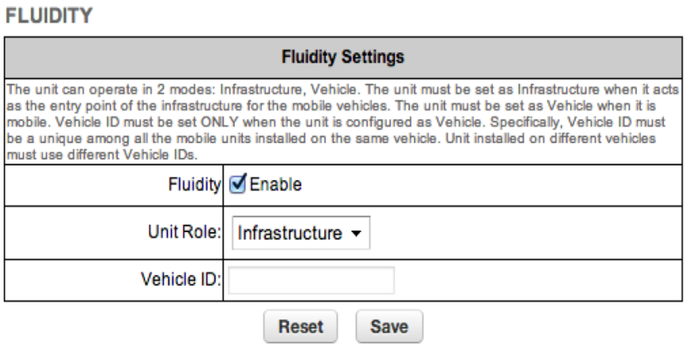

Figure 2. Fluidity Infrastructure Node Configuration

The Fluidity Settings configuration controls allow you to set a device's Fluidity role. A device must be configured to operate as *Infrastructure* if it belongs to the static backbone, and must be configured as *Vehicle* if it is a mobile radio.

If a device's unit role is set as *Vehicle*, the *Vehicle ID* value must be specified as a unique identifier of the vehicle. If multiple Fluidity devices are installed on the same vehicle, all devices must use the same *Vehicle ID* value.

FM-Quadro

Cisco Ultra-Reliable Wireless Backhaul devices that are set to *Mesh End* or *Bridge* mode can take advantage of a specialized monitoring tool called FM-Quadro. FM-Quadro maps a network's infrastructure units and the mobile units that have formed wireless links to them, in real time.

For each vehicle, a real-time graph indicating the actual RSSI from the relevant infrastructure units is also reported.

IMPORTANT

For detailed instructions on how to configure a device's Fluidity settings, refer to:

- The relevant device user manual
- The FM-Racer configuration manual
- The CLI user manual

For detailed information on a device's FM-Quadro functionality, refer to the *FM-Quadro* section of the relevant device user manual.